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EVALUATION OF NEW LIGHT SOURCES AS MOSQUITO ATTRACTANTS

by

R. W. VAVRA, JR., CPT, MSC
Entomology Department
U S Army Medical Laboratory

E. SCOTT TOMLINSON, JR.
Biological Sciences Branch
U S Army Land Warfare Laboratory

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Final Report

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The Entomology Department, US Army Medical Laboratory, evaluated the following prototype light sources for replacement of the standard battery operated incandescent lamp in the CDC mosquito light trap. 1. Chemlites (chemicaluminescent lights) 2. Betalights a. Blue b. Yellow		

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20. ABSTRACT (cont)

- c. Green
- d. White

3. Blinking miniature neon lamp.

Field tests were conducted in the Pocomo Swamp, Maryland, and the Panama Canal Zone.

Test results indicate that the chemilite attracted a comparable number of mosquitos and could be economically superior to the standard battery powered incandescent lamp.

All other prototype lamps were inferior in their attractant capabilities when compared to the standard light source.

The blinking neon lamp developed physical problems which hindered its evaluation.

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FOREWORD

The work described was performed by the Entomology Department, US Army Medical Laboratory, Fort Meade, under USALWL Task 05-B-73, Entomological Use of Lights.

The purpose of the Task was to evaluate several prototype light sources against the present standard light source employed in the standard mosquito light trap.

The assistance of Raymond Hollis, USALWL, in carrying out the field tests is greatly acknowledged.

INTRODUCTION

The present standard light source for the CDC mosquito light trap is a miniature incandescent bulb powered by a battery. In addition, there is a small fan incorporated in the trap which is also driven by the same power source. When powered by four D-size carbon-zinc cells, trap operation is limited to a single night. To extend the operational time, the present solution is to substitute a 6-volt dry cell (lantern battery or "hot shot") for the D batteries. This, however, substantially increases the operational cost. A possible solution to the problem of increasing the operational life of the mosquito light trap is to provide a light source that is not dependent on a battery for power.

To ascertain the feasibility of such a solution to this problem, several candidate light sources were evaluated. These light sources fell into two categories (1) sources that require no external power, and (2) sources that have a reduced power requirement.

MATERIALS AND PROCEDURES

The two following types of lights requiring no external power source were evaluated:

a. Chemlite - a chemiluminescent light stick consisting of a clear plastic tube containing a flourescer (BPEA)¹ and a frangible glass ampoule with hydrogen peroxide. When the ampoule is crushed by pressure applied to the outer plastic tube, the released hydrogen peroxide activates the flourescer which emits a green light (approx. 550 mu).

b. Betalites - a tritium-activated phosphor enclosed in a clear pyrex glass container. Four different phosphors were used to obtain yellow, blue, green, and white lights.

Only one candidate light source with a reduced power requirement was evaluated. This was a blinking light source consisting of a NE-2 neon bulb connected through a .1 mf capacitor and a .5 megohm resistor to a 90 volt battery.

Three field mosquito collection studies were undertaken by the Entomology Department, Ft. Meade, Maryland, to evaluate the candidate light sources. The initial study was conducted at Wallops Base, Virginia, from 11-31 July 1973. The second field study was conducted at Pocomoke Cypress Swamp, Maryland, during the period 1-21 September 1973.

After completing the first two studies, all of the lights were re-evaluated in the Panama Canal Zone during the period 27 October - 2 November 1973.

Field Studies.

Wallops Base, Virginia - CDC traps fitted with standard incandescent chemical and blinking lights were placed randomly in blocking fashion throughout the Wallops Base area. Four (4) blocks were established, each having three (3) traps. Within a given block, each trap contained a different light source. Thus, there were four (4) replications of each light. A total of 272 trap nights were recorded during the three (3) week period.

Pocomoke Cypress Swamp, Maryland - CDC traps with the various lights to be tested were again placed randomly in blocking fashion throughout the swamp. Within a given block, each trap contained a different light source. Originally, there were to have been three (3) blocks, each one containing seven (7) traps. However, due to logistical problems, it was possible to provide only two (2) standard and two (2) blinking traps. Thus, a total of 19 traps were established, (7 in block I, 7 in block II, and 5 in block

¹BPEA - 9, 10 bis (phenyl ethynyl) anthracene

III) each light source having three replications with the exception of the standard and blinking, which had only two replications each. A total of 371 trap nights were recorded during the Pocomoke Cypress Swamp study. During both studies, light traps were activated 1/2 hour prior to sunset each evening, and catches collected 1/2 hour following sunrise the next morning. Traps were located approximately 100 meters apart within blocks. Additionally, control traps were utilized from time to time in which only the trap motor was run and no light was used.

Panama Canal Zone - Farfan Swamp was selected as the test area in the zone. Seven (7) CDC traps, each containing a different light source, were placed at random throughout the test area, and rotated nightly in order to reduce the effect of trap sites upon mosquito catches. Trapping was conducted for seven (7) consecutive nights during which 49 trap nights were recorded. A control trap, utilizing the fan only was operated in random locations on the first and seventh nights. All light traps were located 100 meters apart, and activated 1/2 hour prior to sunset. Mosquito catches were collected the following morning 1/2 hour following sunrise.

Statistical Procedures.

The trap index was selected as the tool by which to measure the effectiveness of each light source as a mosquito attractant. The trap index can be defined as the number of mosquitoes per trap night (one trap night is one trap operated for one night). For statistical purposes, each of the colored radioactive lights were treated as a separate variant. Data accumulated during the Wallops Base and Pocomoke Swamp studies were subjected to an analysis of variance of randomized blocks using a 5% level of error. The standard error of the mean was then used to calculate Duncan's New Multiple Range Test at the 5% level. In order to reduce the variability between nights and weeks, all data was standardized by converting trap index means into natural logs. Data accumulated during the Panama study was subjected to an analysis of variance utilizing a 7 x 7 Latin Square Design at the 5% level of error. No conversion was necessary since the variability between nights was not significant.

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DISCUSSION

Results: Analysis of variance tests performed with data accumulated during the course of the investigation demonstrated the following:

Wallops Base, Virginia.

a. There was a significant difference between weeks with respect to numbers of mosquitoes trapped by all light sources. Average trap indices for weeks 1-3 were recorded as 28, 19 and 18 respectively.

b. No significant difference was noted among the four blocks. That is, the number of mosquitoes trapped in each block did not differ significantly.

c. There was a significant difference among some of the light trap sources in terms of performance. (See Table 1). The standard and chemical lights compared similarly with one another. Statistically, each was as attractive as the other. However, the blinking light performed very poorly and was much less attractive than either the standard or the chemical. Control traps operated from time to time during the three (3) week period produced no significant mosquito catches. A total of two (2) mosquitoes were captured utilizing only motors with no lights.

Pocomoke Swamp, Maryland.

a. There was a significant difference between weeks with respect to numbers of mosquitoes trapped by all light sources. Average trap indices for weeks 1-3 were recorded as 2245, 337 and 69 respectively.

b. No significant difference was noted among the three blocks. That is, the number of mosquitoes trapped in each block did not differ significantly.

c. There was significant difference among some of the light trap sources in terms of performance. (See Table 2). The standard, chemical, Rad-blue, Rad-green and Rad-white sources compared similarly with one another. However, the Rad-yellow and the blinking light sources were extremely less efficacious than the others.

Although Duncan's New Multiple Range Test demonstrates an inter-relationship (no significant difference) among chemical, standard, blue, green and white, it can be seen from Table 2 that the average trap indices vary widely from left to right between chemical and white. Since Rad-green and Rad-white overlap with Rad-yellow, their position is not clear. It may be that green and white are more closely related to yellow and blinking than to chemical, standard and blue. Only further experimental evidence can clarify that situation. In the investigator's opinion of the alternate light sources utilized, chemical is clearly superior to all. Among the radioactive sources, blue compares similarly with chemical and therefore, is more attractive than either green, yellow or white.

The blinking light source is by far the least efficacious of any of the light sources evaluated.

Control traps operated from time to time during the three (3) week period produced no significant mosquito catches. A total of 17 mosquitoes were captured utilizing only motors with no light sources.

Panama Canal Zone.

There was a significant difference in performance among some of the light sources. (See Table 3). Statistically, standard outperformed chemical, which in turn outperformed Rad-blue, Rad-green, Rad-yellow, Rad-white and blinking. No significant difference was noted among any of the radioactive or blinking lights.

The two control traps, operated on the first and seventh nights, produced no significant mosquito catches. A total of eight (8) mosquitoes were collected in the controls.

Evaluation and Discussion: Based upon the results of the three (3) field studies, the chemical light is clearly a suitable substitute for the standard incandescent bulb. At Wallops Base, it performed as well as the standard. During the Pocomoke Swamp study, the chemical actually outperformed the standard, (higher trap index) although statistically there was no significant difference in attractiveness. Only in Panama, did the standard light significantly attract more mosquitoes than the chemical light. It is difficult to determine the reason for this reversal in performance. Perhaps, the behavioral response towards light in the Panamanian mosquito fauna is quite different from the response elicited by mosquitoes inhabiting the Wallops/Pocomoke area.

It is difficult to evaluate the radioactive lights because of the conflicting results obtained during the course of the project. Statistically, the blue, green and white lights performed as well as the standard incandescent light at Pocomoke Swamp. During the Panama study, however, none of the radioactive lights compared similarly to the standard light, as measured by analysis of variance. A close examination of one of the radioactive lights during the course of the project demonstrates the difficulty in assessing their effectiveness as mosquito attractants. At Pocomoke, the blue light attracted an average of 965 mosquitoes per trap over the three(3) week period, as compared to the standard which attracted 1102. In other words, the standard only attracted 12% more mosquitoes than the blue light. These results show the blue light to be an excellent substitute for the standard. On the other hand, in Panama, the average trap index for the blue light was only 30 as compared to the standards 253; an 88% difference in performance. One would have to conclude from these results that the blue light was a poor substitute for the standard. The only apparent consistency concerning the radioactive lights is the fact that when compared with each other, the blue is the best attractant. This is interesting since blue is considerably less bright than the others. (See Table 4). Blue, however, possess the shortest wavelength, 475 microns, which is closer to the ultraviolet light spectrum as compared to the others.

It is well known that many insects are attracted by UV light. In fact, this is the principle utilized in blacklight traps. Therefore, the most important factor contributing to the success of the blue light might have been the wavelength.

The blinking light was clearly the poorest mosquito attractant of the alternate light sources tested. One advantageous characteristic exhibited by the blinking light, however, was the fact that very few trash insects were attracted to it.

Actually, although the blinking light performed poorly, it may have the greatest potential because of its low cost. (See Problem Areas and Recommendations.)

Problem Areas and Recommendations: Light traps. The CDC miniature light traps received from LWL contained the new Barber-Colman motors which were guaranteed for 2000 hours service. However, during the fourth week of the Pocomoke study, the motors on 13 of the traps began to burn out. At this point in the project, the motors had been operated for only 850 total hours, far short of the guaranteed service. Thus, although the Pocomoke study was conducted from 1 - 30 September, only the first three (3) weeks of data could be utilized for statistical purposes. It was learned later, that the traps purchased from Hausherr's Machine Works by LWL were part of a bad shipment.

Light Sources.

a. Chemical lights - No problems were encountered with the chemical lights. They proved to be efficient light emitters. In addition, the chemical lights were light and compact, thus facilitating ease of handling in the field. In the opinion of this investigator, the Chemlights effectiveness could be enhanced by: (1) changing to a white light (2) increasing the luminance while at the same time maintaining the current duration.

b. Radioactive lights - The radioactive lights are not practical for use in the military as mosquito attractants. Since they contain a radioisotope, namely, gaseous tritium, an Atomic Energy Commission license is a prerequisite for their use. The possession of an AEC license for this particular form of radioactive material is not the limiting factor, however. The major drawbacks in using them are safety and security.

In its present configuration, the Betalight containing the tritium does not pose an actual health hazard for the user.. The potential for hazard does exist however, should the Betalight be broken. Therefore, precautions must be taken to preclude individuals not aware of the potential health hazard from becoming accidentally exposed to the Betalights when they are in use in the field. It is very difficult, however, to provide the kind of security necessary to safeguard radioactive lights when they are distributed over a large area.

Due to the technical problems associated with their use, in addition to their dubious performance, Betalights are not recommended for use in the

military as mosquito attractants.

c. Blinking lights - In the configuration in which it was tested, the blinking light was extremely difficult to handle. The following problems were encountered: (1) The slightest contact with the bulb caused it to break. There were numerous occasions during the course of the project when it therefore, became necessary to replace glow bulbs. Breakage occurred not only during handling but also when the blinker was in use in the field. Since it was impossible to securely fasten the bulb to the light trap, on windy nights the force of air currents would sometimes cause the blinker to hit against the side of the trap, causing breakage. (2) Under extremely humid conditions or during rainy nights, the power pack would become wet, causing a short in the system. This occurred even though the batteries were adequately enclosed in plastic. There were many instances when a night's worth of data was lost due to wet, inoperative blinkers.

The blinking light does have some attractive power. For example, during week one (1) at Pocomoke, the average trap index per blinker was 1266 as compared to 2588 for the standard. Although a trap index of 1266 is considerable, it is misleading. Week one (1) at Pocomoke was rather unusual because of the extremely high population of mosquitoes present. Any light source, regardless of its luminous, will attract mosquitoes if they are super abundant.

In the opinion of the investigator, the present light is simply not strong enough to attract large numbers of mosquitoes. Certainly the performance of the blinker would be improved by increasing the brightness of the light pulse.

Additionally, the configuration of the blinker should be modified to (1) make it more durable (2) more adequately protect the batteries from becoming damp or wet. If the above modifications could be made without a significant increase in cost, the blinker might prove to be an excellent substitute for the standard incandescent bulb.

Cost Analysis: The six (6) volt dry cell and the "D" size carbon zinc flashlight battery are the two types of power sources available in the Army for use with the CDC miniature light trap. (Approximate costs are \$1.00 and \$.07 respectively.) Although carbon zinc batteries may be utilized to power both the light and motor, it is often difficult to obtain even one night's operation under extremely hot and humid conditions. Therefore, six (6) volt dry cells are the batteries of choice when operating the standard CDC trap.

If four (4) carbon zinc flashlight batteries are used to operate a trap in which the incandescent bulb has been removed, and replaced by a Chemlite (approximate cost \$.50 each), these "D" cells will power the motor for three (3) consecutive nights.

Using the above data, cost per night for the standard utilizing a six (6) volt battery, and the chemical utilizing "D" cells are approximately \$1.00 and \$.59 respectively.

CONCLUSIONS

The following conclusions are based upon average trap indices obtained during the course of the entire project. They are not predicated upon results of statistical analysis.

1. The chemical light is an excellent substitute for the standard incandescent bulb.

2. The blinking light nor any of the radioactive lights are suitable substitutes for the standard incandescent bulb.

Table 1. Comparison of Light Source Attractants at Wallops Base, Va.
Using Duncan's New Multiple Range Test at the 5% Level of Error.

Variants	Standard	Chemical	Blinking
Means ¹	17	13	0.8
Relationship			

¹ Average trap indices

Table 2. Comparison of Light Source Attractants at Pocomoke Swamp, Md.
Using Duncan's New Multiple Range Test at the 5% Level of Error.

Variants	Chemical	Standard	Blue	Green	White	Yellow	Blink
Means ¹	1366	1102	965	871	602	426	318
Relationship							

¹ Average trap indices

Table 3. Comparison of Light Source Attractants in the Panama Canal Zone Using a 7x7 Latin Square Design at the 5% Level of Error.

Variants	STD	CHEM	BLU	GR	YL	BLK	WH
Means ¹	252	114	30	27	25	8	3
Relationship							

¹ Average trap indices

Table 4. BetaLight Parameters

Colors	Brightness ¹	Dominant Wavelength ²
Yellow	1300	570
Green	1300	540
Blue	390	473
White	975	unknown

¹ Measured in microlamberts

² Measured in microns

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